

(19)



Europäisches Patentamt

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(11)

**EP 1 046 546 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
25.10.2000 Bulletin 2000/43

(51) Int Cl.7: **B60R 19/22, B60R 19/18**

(21) Application number: 99108129.0

(22) Date of filing: 24.04.1999

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventor: **Howard, Mark**  
52070 Aachen (DE)

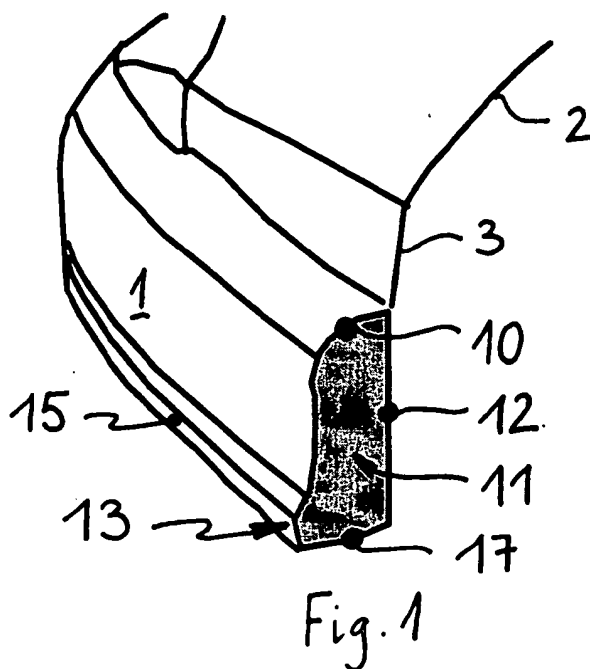
(74) Representative:  
**Drömer, Hans-Carsten, Dipl.-Ing. et al**  
**Ford-Werke Aktiengesellschaft,**  
**Patentabteilung NH/DRP**  
50725 Köln (DE)

(71) Applicant: **Ford Global Technologies, Inc.,**  
**A subsidiary of Ford Motor Company**  
Dearborn, Michigan 48126 (US)

**(54) Bumper for vehicles having optimal mechanical properties to improve pedestrian protection**

(57) The bumper (1) is designed to have optimal mechanical properties which improve the pedestrian protection. The bumper essentially consists of a cover (10), an absorber (optional) (21,22,23) arranged beneath the cover and the mounting elements to connect a cover and absorber to the vehicles body. The optimal mechanical properties to improve the pedestrian protection are

according to the invention achieved by various embodiments, the general principle of which is that the stiffness of the lower portion of the bumper in its mounted position is increased relative to the upper portion of the bumper. By making the lower portion of the bumper which is directed forwardly into the direction of driving stiffer, the impact force in case of collision with a pedestrian is concentrated on the lower portion of the bumper.





## Description

[0001] The bumper, more specifically the front bumpers shape, is an important factor in improving the pedestrian protection. In the case of a collision, the position of the first impact determines the further motion of the body. Furthermore, with a lower point of impact the risk of knee ligament injuries may be reduced.

[0002] With that background the German patent 30 51 041 C2 describes an adjustable protector element which in a retracted position is aerodynamically optimized and when moved forward in the direction of driving and into a lowered position ensures first of all that the point of impact will be lowered and the pedestrian is tilted onto the front end of the vehicle. Only if the forces at the protecting element exceed 10 000 N, the protector will recede until its front face is approximately flush with that of the bumper.

[0003] The protector described in this patent is a relatively complicated and costly construction and due to minimum requirement as to the angle of clearance to the lower front end of the car, it is not usable for all types of cars.

[0004] In view of the existing prior art, the problem to be solved is to provide a pedestrian protection device preferably to be used on the front of the car which lowers the point of impact without using further installations beneath the bumper.

[0005] This problem is solved by designing the bumper to have optimal mechanical properties which improve a pedestrian protection. The bumper essentially consists of a cover, an absorber (optional) arranged beneath the cover and the mounting elements to connect a cover and absorber to the vehicles body. The optimal mechanical properties to improve the pedestrian protection are according to the invention achieved by various embodiments, the general principle of which is that the stiffness of the lower portion of the bumper in its mounted position is increased relative to the upper portion of the bumper. By making the lower portion of the bumper which is directed forwardly into the direction of driving stiffer, the impact force in case of collision with a pedestrian is concentrated on the lower portion of the bumper. Thus during the earliest phase of the impact, the force exerted onto the pedestrian is applied at a relatively low position so that the risk of knee ligaments is reduced. It is especially important that the relatively stiff lower portion is an integral part of the bumper, because of the interaction of forces exerted onto the pedestrian and the deformation of the lower portion of the bumper and the bumper as a whole during each phase of the impact. In other words, by making the device - which first impacts the pedestrian at a relatively low height - an integral part of the bumper, the mechanical properties of the bumper such as bending and the deformation of the bumper can be included in the overall bumper design which includes the optimization of the cover, the absorber (optional) and the supporting element with re-

spect to the mechanical properties in the cross sectional and the longitudinal direction of the bumper. The variation in mechanical stiffness from the top to the bottom of the bumper can be achieved by various means. E.g. a lamellar structure for the cover and/or the absorber and/or the supporting structure or mounting element. With such a lamellar structure, the mechanical properties varies from lamella to lamella and perpendicular to the direction of stacking a shearing force would be required.

[0006] Preferably, the cover and/or the absorber would be optimized with respect to their mechanical properties in order to make the lower portion of the bumper stiffer than the upper portion. This construction, however, must not necessarily include an absorber at all or the absorber may be arranged on the front surface of the cover.

[0007] Preferably, the lower portion of the cover has the form of a lip extending forwardly into the direction of driving relative to the upper portion. This lip typically would have in a vertical cross section of the bumper in its mounted position at least a partly straight, approximately vertical front surface. The lip could have various cross sectional shapes, e.g. half circle, half oval, rectangular etc. The impact force is maintained on the lower part of the leg throughout the pedestrian impact and the leg is rotated by this lip away from the ground that means, the center of rotation of the leg is lowered.

[0008] The lip may be created by a variety of means. For instance, a chromed plastic strip can be added to the lower part of the bumper's face or the bumper is molded in such a way that a lip is formed on the lower portion. This single bumper system with integrated design characteristics is specifically suitable to reduce pedestrian knee injuries.

[0009] Particularly the lip arranged at the lower portion of the bumper may consist of a bottom section forming the foremost point of contact followed in the upward direction by a sloped section tapering gradually towards the upper portion of the bumper. The partly straight approximately vertical front surface may be reduced to a tangential line on a curved surface.

[0010] Preferably, the cross sectional area (measured between the front contour of the bumper and a vertical line) of the lower portion (the lower half, below the middle-line) of the bumper is greater than the respective cross sectional area of the upper portion. Particularly, the height of the lip formed at the lower portion of the bumper is less than half of the bumpers height. In making the height of the lower portion less than half of the bumpers height, the force distribution in case of an impact is concentrated more to the lower end of the bumper which again is advantageous to reduce knee injuries.

[0011] As an alternative or in order to support the effect of the geometry described above a reinforcing structure is arranged on the inner surface of the cover in the range of the lower portion of the bumper. Such structure preferably consists essentially of a surface connecting

the front part of the cover and the lower flange which at the bottom is bent backwardly towards the body. Such surface may extend lengthwise of the bumper but preferably the structure would consist of one or more ribs arranged approximately perpendicular to the inner surface of the bumper in its lower portion. With this reinforcing structure and by adapting the distance between adjacent ribs, the stiffness in the lengthwise direction of the bumper can be optimized. Especially at the end portions where the bumper is bent towards the fenders, the curvature intrinsically increases the stiffness of the bumper. This can be balanced by adjusting the wall thickness of the reinforcing structure and/or by adjusting the distance between adjacent ribs. Thus with the design of this invention, along the length of the bumper optimal stiffness of the bumper can be achieved which could also adjust for the structural effect of the mounting/supporting elements.

[0012] Typically, the reinforcing ribs would have an approximately triangular shape with two sides of this shape formed by the contour of the inner surface of the bumper at its lower corner.

[0013] The design described before can be further optimized and enhance the protective function of the bumper with respect to the pedestrian by filling the spacing between the cover and the mounting/ supporting element or the respective front part of the body at least partially with an absorber foam or cushion which helps to dissipate the energy of impact.

[0014] In a preferred embodiment the foam stiffness in the lower portion of the bumper is higher than the foam stiffness in the upper portion. E.g. the top two thirds of the bumpers height could be filled with a low stiffness foam and the lower third with a high stiffness foam.

[0015] Preferably, the lower portion of the bumper is at least partly filled with a high density foam and the upper portion of the bumper is filled at least partly with a low density foam. The low density foam may extend to the lower portion of the bumper and at least partly surround the high density foam. Alternatively, the high density foam may extend up to the upper portion of the bumper and at least partly enclose the low density foam. By these designs more control over the load on the pedestrians tibia, fibula (lower leg bones) and the knee joint can be achieved. If the lower leg is considered to be a beam, then the manner in which this beam is loaded can be controlled by the distribution of stiffness across the bumper face. This in turn can be controlled by the foam density and in the way, the density is varied throughout the foam absorber. Therefore, in a preferred embodiment, the foam density is varying from top to bottom and from front to depth of the bumper in its mounted position.

[0016] Additionally or alternatively to varying the foam density itself voids may be distributed in the foam. Whereas the density of the foam may be controlled by the material of the foam and its porosity, the additional inclusion of voids would allow to further optimize the

foam stiffness without the restrictions with respect of the material and the porosity which may depend on the production process.

[0017] To further improve the distribution of the bumpers stiffness along its length a reinforcing structure like a beam can be arranged between the cover and/or foam and the mounting elements.

[0018] With respect to the schematic representations given in figures 1 to 4, further explanations on the invention and the various embodiments are given. In Fig. 1, the bumper 1 is attached to the front of the vehicle of which the bonnet 2 and the front grille 3 are schematically shown. The bumper 1 consists of a cover 10 with an opening 11 and optionally a supporting structure 12 which can be a beam extending at least partly into the longitudinal direction of the bumper 1. Either directly to the cover 10 or the supporting structure 12 mounting elements (not shown) serve for the mechanical connection between the bumper 1 and the body of the vehicle. In the lower portion of the bumper a lip 13 is shown which extends forwardly into direction of driving. This lip has an approximately straight vertical front surface 15, an upper flange 16 protruding backwardly and connection the front surface 15 with the part of the cover which extends towards the upper portion of the bumper. At the bottom of the cover a flange 17 is protruding backwardly towards the vehicles body.

[0019] As shown in Fig. 2, the front surface 15 of the lip 13 may be connected to the upper portion of the bumper by a tapered section 16. In the range of the lip 13, ribs 18 are connecting the interior surface of the cover directed forwardly and the interior surface of the flange 17 bent backwardly towards the vehicles body.

[0020] As shown in Fig. 3, the spacing 11 may be filled by two different types of foam, a low stiffness or low density foam 21 and a foam 22 with increased stiffness or density.

[0021] As shown in Fig. 4, the low density foam 21 may extend downwards to partly enclose the high density foam 22 or vice versa the high stiffness foam 22 may extend upwardly and behind the low stiffness foam 21. Between these foams of different stiffness 21 and 22 one or more intermediate areas may be filled with a foam 23 which has an intermediate stiffness or density. The structure of the cover as shown in Fig. 1 and 2 may advantageously combined with the structure of different foams shown in Fig. 3 and 4 to further optimize the pedestrian protection.

## Claims

1. Bumper for vehicles with optimal mechanical properties which improve the pedestrian protection and which essential consists of a cover (10) and a mounting or supporting element to connect the cover the vehicle body, characterized in that,

the vertically lower portion of the bumper (1) in its mounted position has an increased stiffness relative to the upper portion of the bumper.

2. Bumper according to claim 1, 5  
characterized in that,  
in the lower portion of the bumper (1) the cover (10)  
has the form of a lip (13) extending forwardly into  
the direction of driving relative to the upper portion  
of the bumper, which lip in a vertical cross section 10  
of the bumper in its mounted position has an at least  
partly straight approximately vertical front surface  
(15).
3. Bumper according to claim 2, 15  
characterized in that,  
the cross sectional area of the lower portion of the  
bumper (1) is greater than the cross sectional area  
of the upper portion. 20
4. Bumper according to one of the preceding claims,  
characterized in that,  
in the lower portion of the bumper a reinforcing  
structure is arranged which preferably consists es-  
sentially of several ribs (18) arranged approximate- 25  
ly perpendicular to the cover.
5. Bumper according to one of the preceding claims,  
characterized in that,  
the spacing between the cover (10) and the mount- 30  
ing structure is at least partly filled with an absorber  
foam (21, 22, 23).
6. Bumper according to claim 5,  
characterized in that, 35  
the foam (22) has in the lower portion of the bumper  
an increased stiffness.
7. Bumper according to claim 6,  
characterized in that, 40  
the foam (22) in the lower portion of the bumper has  
an increased density.
8. Bumper according to claim 6 or 7,  
characterized in that, 45  
the foam (21, 22) density is varying from top to bot-  
tom and front to depth of the bumpers in its mounted  
portion.
9. Bumper according to one of the claims 6 to 8, 50  
characterized in that,  
voids are distributed in the foam (21, 22, 23).
10. Bumper according to one of the preceding claims,  
characterized in that, 55  
a reinforcing beam (12) is arranged between cover  
(10) and a mounting element.

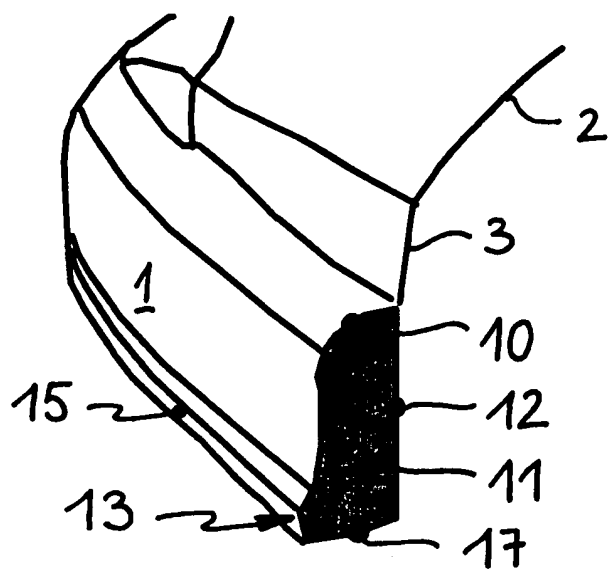


Fig. 1

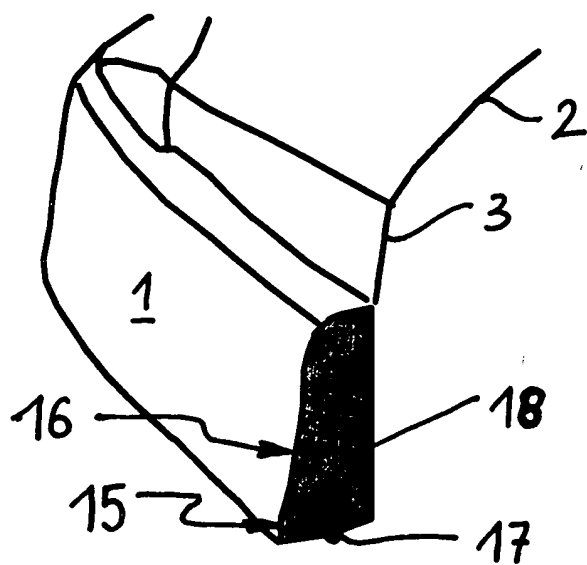


Fig. 2

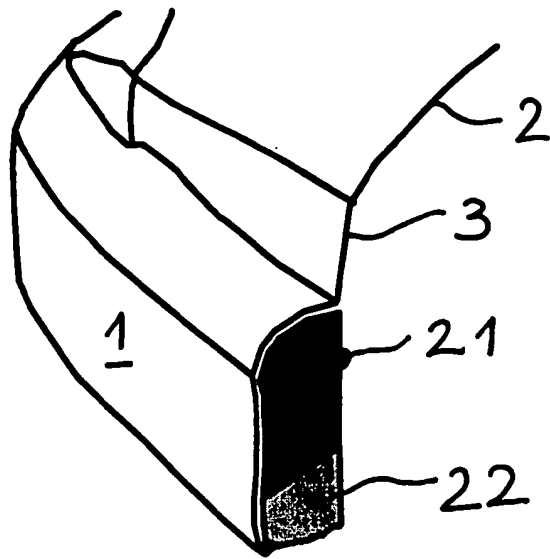


Fig. 3

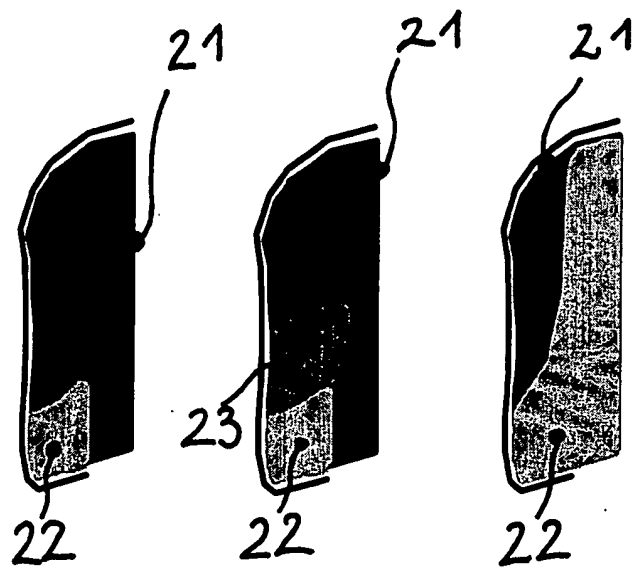


Fig. 4



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Application Number  
EP 99 10 8129

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 2 November 1999	Examiner D'sylva, C
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons - : member of the same patent family, corresponding document</p>			





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EP 99 10 8129

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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>&amp; : member of the same patent family, corresponding document</p>			

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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